

Recent History of BBA at RHIC

01/07/10 and 01/21/10 - vertical and horizontal, respectively, BPM offsets reversed

11/18/10 - Jordan's summary of RUN10 data:

<https://spreadsheets.google.com/ccc?key=0AmW-GBb3lEL2dDdJSmdibHAXTUFxTjNJbW82ZVBCaVE&hl=en#gid=0>

02/01/11 - Phil Pile indicates difficulties rationalizing Turtle simulations with measurements at IR6

02/03/11 - BBA data IR

02/15/11 - inspection of 02/03/11 data

- inconsistency wrt run-10 data noted
- study plan for systematics studies developed

03/04/11 - first pass systematics study (bi8-bh1) ← problem with extensive beam loss (identified later to be due to resonance crossing) ← parasitic to unscheduled LLRF/controls work

03/14/11 - second pass systematics study (bi8-bh1) ← parasitic to RHIC injection kicker/snake quench diagnoses

03/27/11 - third pass systematics study (yo5-bh1) ← parasitic to AGS rf work

04/12/11 - tilted polarization at 12 o'clock inquiry (Roser)

04/21/11 - APEX proposal

References:

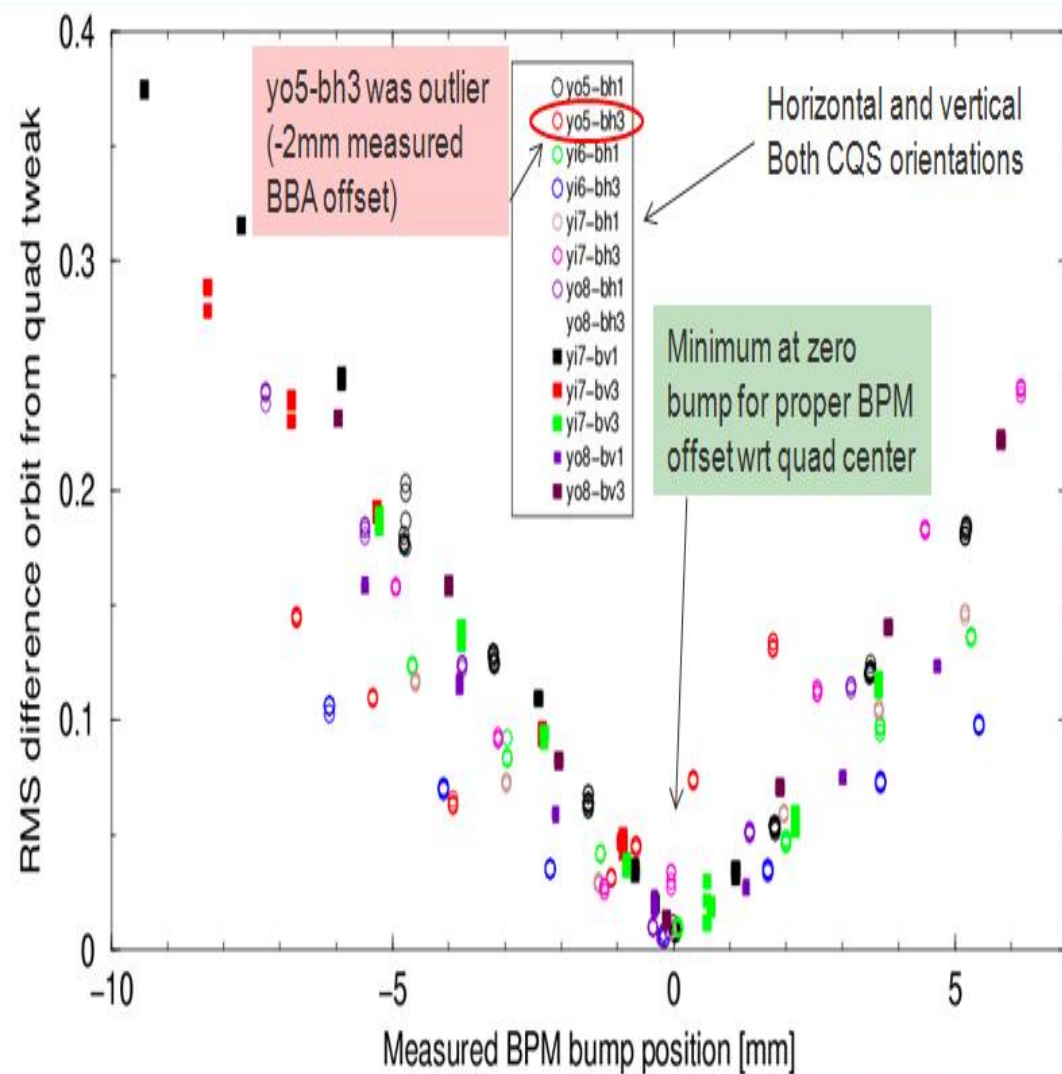
T. Satogata, "Beam-Based Alignment Studies" (APEX workshop)

http://www.c-ad.bnl.gov/RHIC/retreat2005/presentations/Jun17_AM/BBA-Retreat2005.pdf

<https://indico.bnl.gov/conferenceOtherViews.py?view=standard&confId=252>

J. Ziegler's document of BBA offsets (since BPM ADO offset reversal):

<https://spreadsheets.google.com/ccc?key=0AmW-GBb3lEL2dDdJSmdibHAXTUFxTjNJbW82ZVBCaVE&hl=en#gid=0>



BBA offsets measured (near zero) in nearly all yellow low- β IR BPMs

Confirmation that BPM offset correction, including orientations, was correct

| | 2010-02-03 | 2010-03-03 | 2010-03-09 | 2010-04-07 |
|---------|------------|------------|------------|------------|
| yi2-bh1 | | | | 0.790 |
| yi2-bh3 | | | | 0.266 |
| yi6-bh1 | | 0.457 | 0.491 | |
| yi6-bh3 | | 0.064 | -0.161 | |
| yi6-bv1 | | 0.417 | 0.214 | |
| yi7-bh1 | | -0.060 | -0.139 | |
| yi7-bh3 | | -0.437 | -0.260 | |
| yi7-bv1 | | | 0.708 | |
| yi7-bv3 | | 0.934 | | |
| yo1-bh1 | | | | -0.237 |
| yo1-bh3 | | | | 1.584 |
| yo1-bv1 | | | | 0.429 |
| yo1-bv3 | | | | 0.386 |
| yo5-bh1 | | 0.609 | 0.855 | 0.629 |
| yo5-bh3 | | -1.233 | -1.698 | |
| yo5-bv1 | | -0.303 | | |
| yo5-bv3 | | -0.119 | | |
| yo8-bh1 | | -0.173 | 0.162 | |
| yo8-bh3 | | 0.258 | 0.740 | |
| yo8-bv1 | | 0.360 | | |
| yo8-bv3 | | 0.464 | | |

| | | | | |
|---------|--------|--|--------|--------|
| bi5-bh1 | | | 0.944 | 0.509 |
| bi5-bh3 | | | 0.616 | -0.865 |
| bi5-bv1 | | | 0.044 | -0.915 |
| bi5-bv3 | | | 0.689 | 0.836 |
| bi8-bh1 | | | | 0.137 |
| bi8-bh3 | | | | -0.368 |
| bi8-bv1 | | | | 0.121 |
| bi8-bv3 | | | | 0.051 |
| bo6-bh1 | | | 1.470 | |
| bo6-bh3 | | | 1.172 | |
| bo6-bv1 | | | -1.198 | |
| bo6-bv3 | | | -0.372 | |
| bo7-bh1 | -0.250 | | | |
| bo7-bh3 | | | | 0.048 |
| bo7-bv1 | 0.450 | | | |
| bo7-bv3 | | | | -0.537 |

← run-10 →

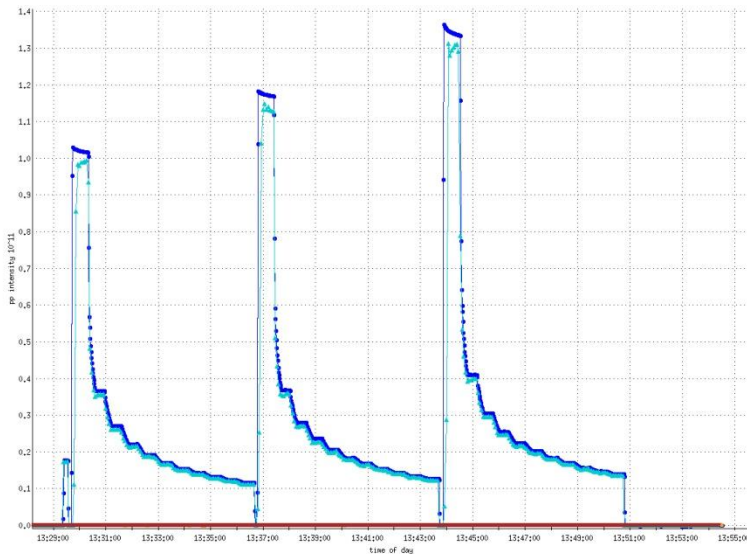
← run-11 →

| 1 | Date → | 2010-02-03 | 2010-03-03 | 2010-03-09 | 2010-04-07 |
|----|---------|---|------------|------------|------------|
| 2 | Plots → | http://tinyurl.com/5ti75gj | | | |
| 3 | ↓ BPM ↓ | BBA Results [mm] | | | |
| 4 | bi5-bh1 | | | 0.944 | 0.509 |
| 5 | bi5-bh3 | | | 0.616 | -0.865 |
| 6 | bi5-bv1 | | | 0.044 | -0.915 |
| 7 | bi5-bv3 | | | 0.689 | 0.836 |
| 8 | bi8-bh1 | | | | 0.137 |
| 9 | bi8-bh3 | | | | -0.368 |
| 10 | bi8-bv1 | | | | 0.121 |
| 11 | bi8-bv3 | | | | 0.051 |
| 12 | bo6-bh1 | | | 1.470 | |
| 13 | bo6-bh3 | | | 1.172 | |
| 14 | bo6-bv1 | | | -1.198 | |
| 15 | bo6-bv3 | | | -0.372 | |
| 16 | bo7-bh1 | -0.250 | | | |
| 17 | bo7-bh3 | | | | 0.048 |
| 18 | bo7-bv1 | 0.450 | | | |
| 19 | bo7-bv3 | | | | -0.537 |

| 2011-02-03 |
|------------|
| 0.017 |
| -1.461 |
| -3.686 |
| 0.162 |
| -0.681 |
| -0.068 |
| -0.089 |
| -0.036 |
| 1.078 |
| 0.078 |
| 0.221 |
| -0.044 |
| 56.722 |
| -0.001 |
| 36.364 |
| -0.059 |

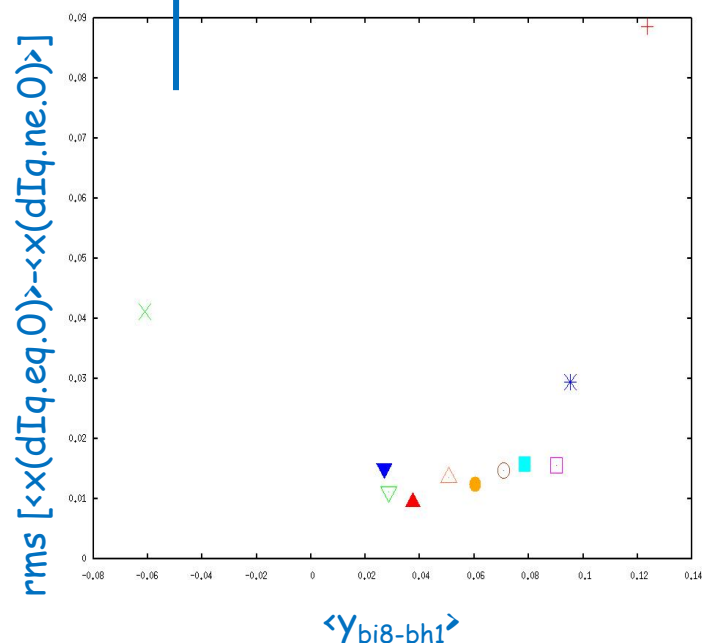
[illegible]

first pass
systematics
study: repeat
scan 3 times



dQ=1E-3
Qy_min=0.675
Y(I)

→80 micron
peak-to-peak
variation in $y_{bi8-bh1}$

2011-03-14

| | | |
|--------|--------|--------|
| 0.283 | 0.728 | -0.156 |
| -0.230 | -0.480 | -0.385 |
| -0.484 | | |
| -0.459 | | |

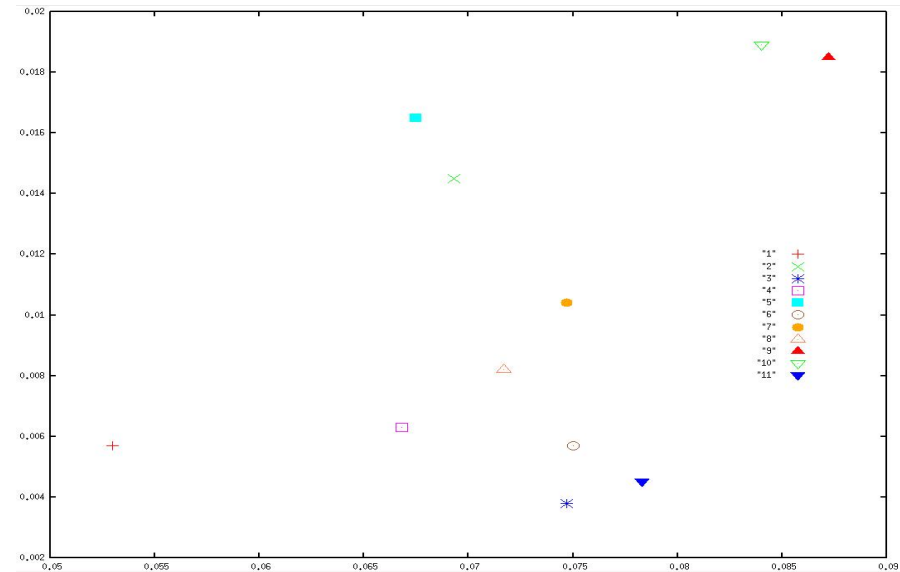
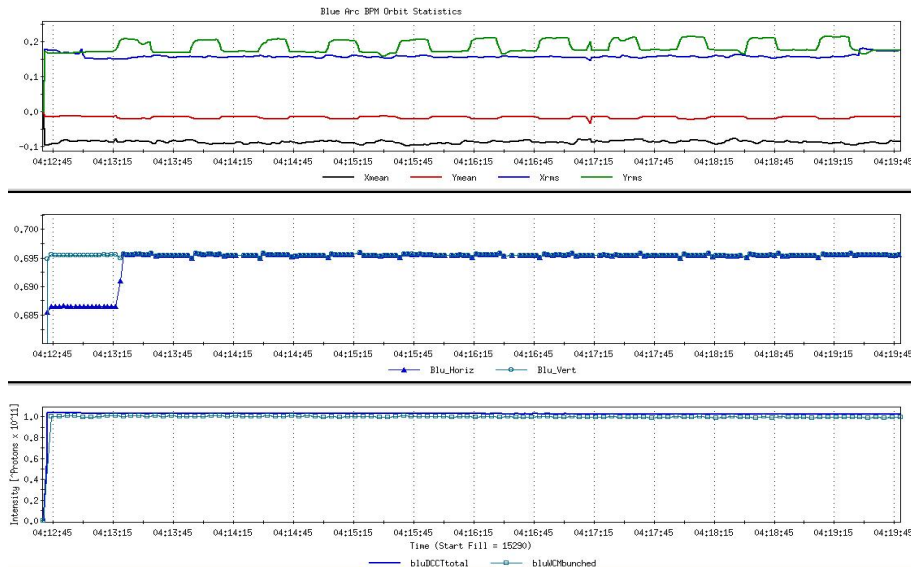
second
pass syste-
matics
study: no
change
in bump,
change in
quad
strength
only

$dQ=5e-4$

$Q_{y_min}=0.685$ (raised)

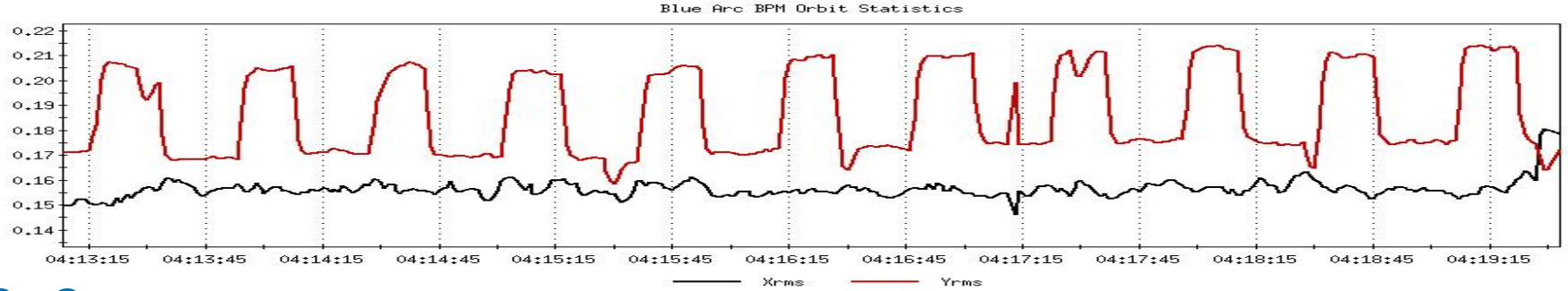
$Y_{ne.Y(I)}$

→50 micron
peak-to-peak
variation in $\gamma_{bi8-bh1}$

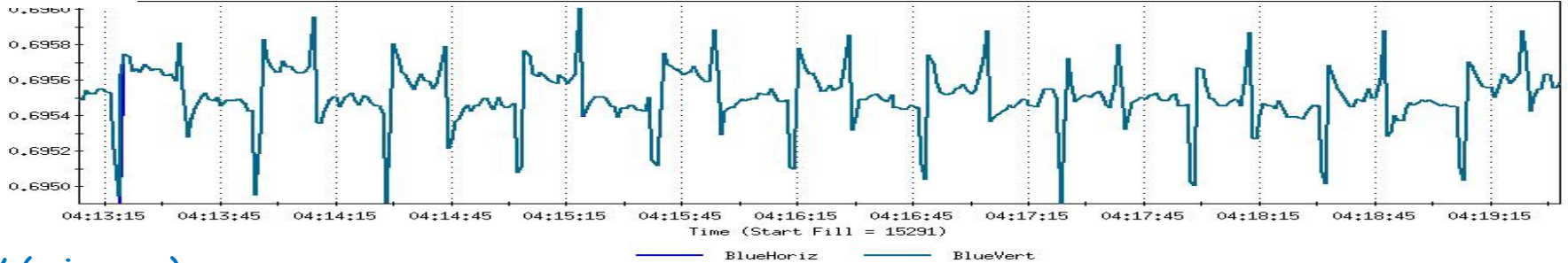


⇒ reproducibility still not consistent with <10 micron BPM resolution (I think)

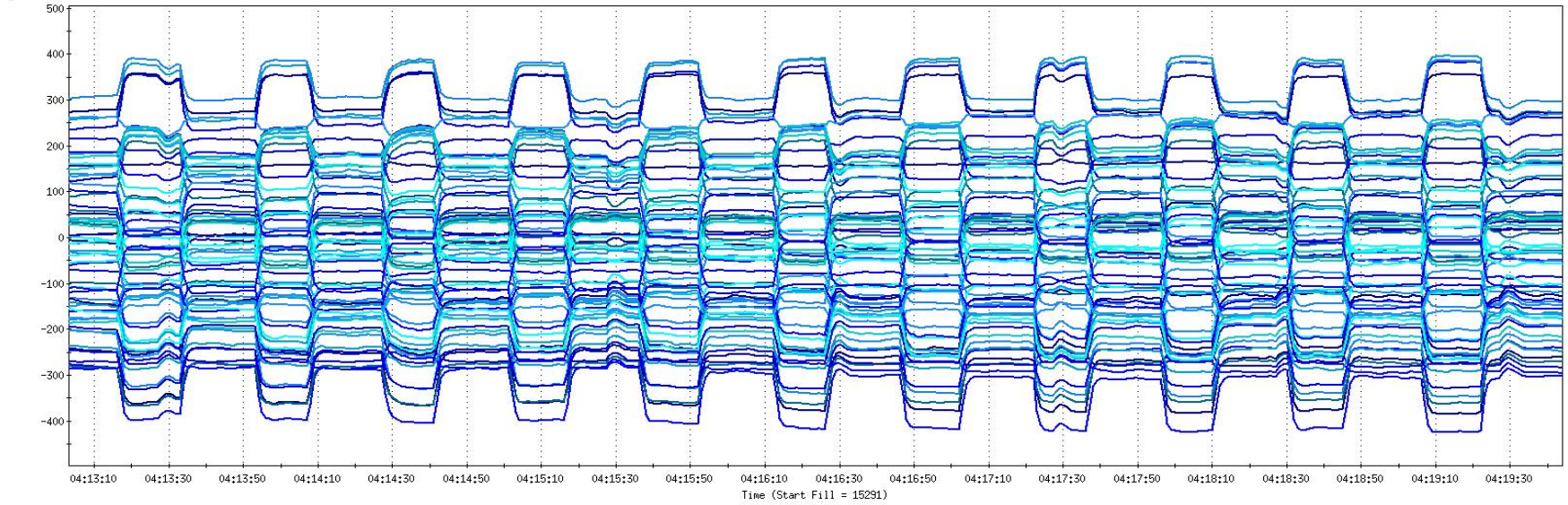
xrms, yrms



Qx,Qy

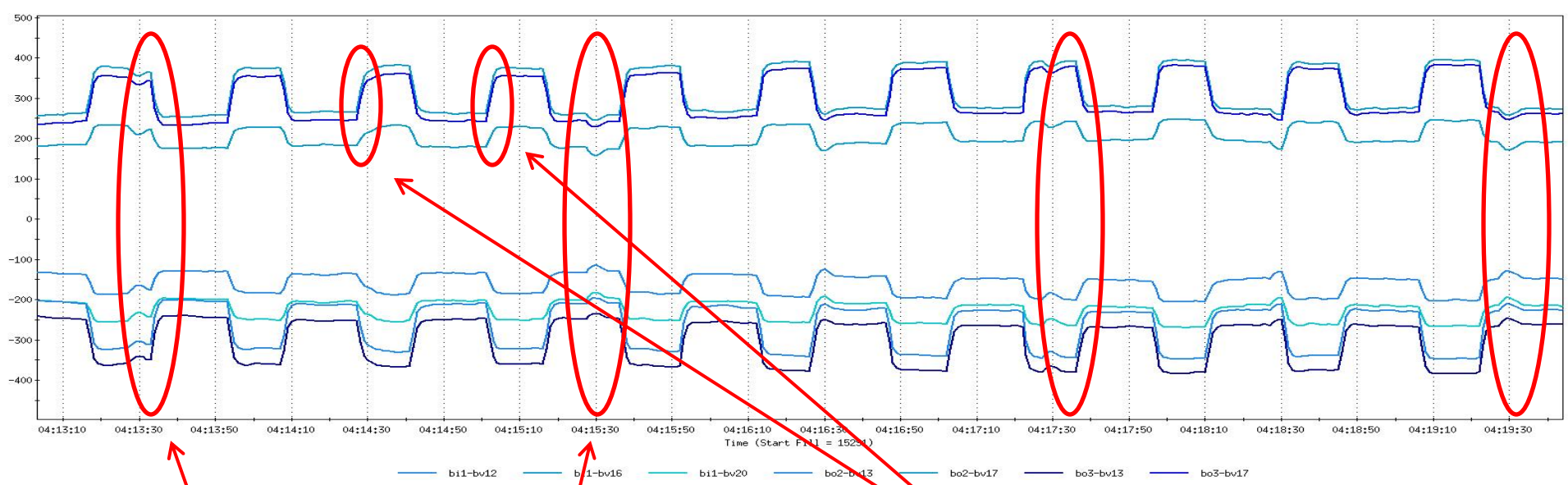


Y (microns)



- | | | | | | | | | | | | | | | | |
|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|-------------|-------------|-------------|-------------|-------------|-------------|
| — b11-bv12 | — b11-bv14 | — b11-bv16 | — b11-bv18 | — b11-bv20 | — b12-bv11 | — b12-bv13 | — b12-bv15 | — b12-bv17 | — b12-bv19 | — b12-bv21 | — b13-bv12 | — b13-bv14 | — b13-bv16 | — b13-bv18 | — b13-bv20 |
| — b14-bv12 | — b14-bv14 | — b14-bv16 | — b14-bv18 | — b14-bv20 | — b15-bv11 | — b15-bv13 | — b15-bv15 | — b15-bv17 | — b15-bv19 | — b15-bv21 | — b16-bv12 | — b16-bv14 | — b16-bv16 | — b16-bv18 | — b16-bv20 |
| — b17-bv11 | — b17-bv13 | — b17-bv15 | — b17-bv17 | — b17-bv19 | — b18-bv12 | — b18-bv14 | — b18-bv16 | — b18-bv18 | — b18-bv20 | — b19-bv11 | — b19-bv13 | — b19-bv15 | — b19-bv17 | — b19-bv19 | — b20-bv12 |
| — b20-bv13 | — b20-bv15 | — b20-bv17 | — b20-bv19 | — b20-bv21 | — b21-bv12 | — b21-bv14 | — b21-bv16 | — b21-bv18 | — b21-bv20 | — b22-bv11 | — b22-bv13 | — b22-bv15 | — b22-bv17 | — b22-bv19 | — b22-bv21 |
| — b23-bv12 | — b23-bv14 | — b23-bv16 | — b23-bv18 | — b23-bv20 | — b24-bv11 | — b24-bv13 | — b24-bv15 | — b24-bv17 | — b24-bv19 | — b25-bv12 | — b25-bv14 | — b25-bv16 | — b25-bv18 | — b25-bv20 | — b26-bv11 |
| — b26-bv13 | — b26-bv15 | — b26-bv17 | — b26-bv19 | — b26-bv21 | — b27-bv12 | — b27-bv14 | — b27-bv16 | — b27-bv18 | — b27-bv20 | — b28-bv11 | — b28-bv13 | — b28-bv15 | — b28-bv17 | — b28-bv19 | — b28-bv21 |
| — b29-bv12 | — b29-bv14 | — b29-bv16 | — b29-bv18 | — b29-bv20 | — b30-bv11 | — b30-bv13 | — b30-bv15 | — b30-bv17 | — b30-bv19 | — b31-bv12 | — b31-bv14 | — b31-bv16 | — b31-bv18 | — b31-bv20 | — b32-bv11 |
| — b32-bv13 | — b32-bv15 | — b32-bv17 | — b32-bv19 | — b32-bv21 | — b33-bv12 | — b33-bv14 | — b33-bv16 | — b33-bv18 | — b33-bv20 | — b34-bv11 | — b34-bv13 | — b34-bv15 | — b34-bv17 | — b34-bv19 | — b34-bv21 |
| — b35-bv12 | — b35-bv14 | — b35-bv16 | — b35-bv18 | — b35-bv20 | — b36-bv11 | — b36-bv13 | — b36-bv15 | — b36-bv17 | — b36-bv19 | — b37-bv12 | — b37-bv14 | — b37-bv16 | — b37-bv18 | — b37-bv20 | — b38-bv11 |
| — b38-bv13 | — b38-bv15 | — b38-bv17 | — b38-bv19 | — b38-bv21 | — b39-bv12 | — b39-bv14 | — b39-bv16 | — b39-bv18 | — b39-bv20 | — b40-bv11 | — b40-bv13 | — b40-bv15 | — b40-bv17 | — b40-bv19 | — b40-bv21 |
| — b41-bv12 | — b41-bv14 | — b41-bv16 | — b41-bv18 | — b41-bv20 | — b42-bv11 | — b42-bv13 | — b42-bv15 | — b42-bv17 | — b42-bv19 | — b43-bv12 | — b43-bv14 | — b43-bv16 | — b43-bv18 | — b43-bv20 | — b44-bv11 |
| — b44-bv13 | — b44-bv15 | — b44-bv17 | — b44-bv19 | — b44-bv21 | — b45-bv12 | — b45-bv14 | — b45-bv16 | — b45-bv18 | — b45-bv20 | — b46-bv11 | — b46-bv13 | — b46-bv15 | — b46-bv17 | — b46-bv19 | — b46-bv21 |
| — b47-bv12 | — b47-bv14 | — b47-bv16 | — b47-bv18 | — b47-bv20 | — b48-bv11 | — b48-bv13 | — b48-bv15 | — b48-bv17 | — b48-bv19 | — b49-bv12 | — b49-bv14 | — b49-bv16 | — b49-bv18 | — b49-bv20 | — b50-bv11 |
| — b50-bv13 | — b50-bv15 | — b50-bv17 | — b50-bv19 | — b50-bv21 | — b51-bv12 | — b51-bv14 | — b51-bv16 | — b51-bv18 | — b51-bv20 | — b52-bv11 | — b52-bv13 | — b52-bv15 | — b52-bv17 | — b52-bv19 | — b52-bv21 |
| — b53-bv12 | — b53-bv14 | — b53-bv16 | — b53-bv18 | — b53-bv20 | — b54-bv11 | — b54-bv13 | — b54-bv15 | — b54-bv17 | — b54-bv19 | — b55-bv12 | — b55-bv14 | — b55-bv16 | — b55-bv18 | — b55-bv20 | — b56-bv11 |
| — b56-bv13 | — b56-bv15 | — b56-bv17 | — b56-bv19 | — b56-bv21 | — b57-bv12 | — b57-bv14 | — b57-bv16 | — b57-bv18 | — b57-bv20 | — b58-bv11 | — b58-bv13 | — b58-bv15 | — b58-bv17 | — b58-bv19 | — b58-bv21 |
| — b59-bv12 | — b59-bv14 | — b59-bv16 | — b59-bv18 | — b59-bv20 | — b60-bv11 | — b60-bv13 | — b60-bv15 | — b60-bv17 | — b60-bv19 | — b61-bv12 | — b61-bv14 | — b61-bv16 | — b61-bv18 | — b61-bv20 | — b62-bv11 |
| — b62-bv13 | — b62-bv15 | — b62-bv17 | — b62-bv19 | — b62-bv21 | — b63-bv12 | — b63-bv14 | — b63-bv16 | — b63-bv18 | — b63-bv20 | — b64-bv11 | — b64-bv13 | — b64-bv15 | — b64-bv17 | — b64-bv19 | — b64-bv21 |
| — b65-bv12 | — b65-bv14 | — b65-bv16 | — b65-bv18 | — b65-bv20 | — b66-bv11 | — b66-bv13 | — b66-bv15 | — b66-bv17 | — b66-bv19 | — b67-bv12 | — b67-bv14 | — b67-bv16 | — b67-bv18 | — b67-bv20 | — b68-bv11 |
| — b68-bv13 | — b68-bv15 | — b68-bv17 | — b68-bv19 | — b68-bv21 | — b69-bv12 | — b69-bv14 | — b69-bv16 | — b69-bv18 | — b69-bv20 | — b70-bv11 | — b70-bv13 | — b70-bv15 | — b70-bv17 | — b70-bv19 | — b70-bv21 |
| — b71-bv12 | — b71-bv14 | — b71-bv16 | — b71-bv18 | — b71-bv20 | — b72-bv11 | — b72-bv13 | — b72-bv15 | — b72-bv17 | — b72-bv19 | — b73-bv12 | — b73-bv14 | — b73-bv16 | — b73-bv18 | — b73-bv20 | — b74-bv11 |
| — b74-bv13 | — b74-bv15 | — b74-bv17 | — b74-bv19 | — b74-bv21 | — b75-bv12 | — b75-bv14 | — b75-bv16 | — b75-bv18 | — b75-bv20 | — b76-bv11 | — b76-bv13 | — b76-bv15 | — b76-bv17 | — b76-bv19 | — b76-bv21 |
| — b77-bv12 | — b77-bv14 | — b77-bv16 | — b77-bv18 | — b77-bv20 | — b78-bv11 | — b78-bv13 | — b78-bv15 | — b78-bv17 | — b78-bv19 | — b79-bv12 | — b79-bv14 | — b79-bv16 | — b79-bv18 | — b79-bv20 | — b80-bv11 |
| — b80-bv13 | — b80-bv15 | — b80-bv17 | — b80-bv19 | — b80-bv21 | — b81-bv12 | — b81-bv14 | — b81-bv16 | — b81-bv18 | — b81-bv20 | — b82-bv11 | — b82-bv13 | — b82-bv15 | — b82-bv17 | — b82-bv19 | — b82-bv21 |
| — b83-bv12 | — b83-bv14 | — b83-bv16 | — b83-bv18 | — b83-bv20 | — b84-bv11 | — b84-bv13 | — b84-bv15 | — b84-bv17 | — b84-bv19 | — b85-bv12 | — b85-bv14 | — b85-bv16 | — b85-bv18 | — b85-bv20 | — b86-bv11 |
| — b86-bv13 | — b86-bv15 | — b86-bv17 | — b86-bv19 | — b86-bv21 | — b87-bv12 | — b87-bv14 | — b87-bv16 | — b87-bv18 | — b87-bv20 | — b88-bv11 | — b88-bv13 | — b88-bv15 | — b88-bv17 | — b88-bv19 | — b88-bv21 |
| — b89-bv12 | — b89-bv14 | — b89-bv16 | — b89-bv18 | — b89-bv20 | — b90-bv11 | — b90-bv13 | — b90-bv15 | — b90-bv17 | — b90-bv19 | — b91-bv12 | — b91-bv14 | — b91-bv16 | — b91-bv18 | — b91-bv20 | — b92-bv11 |
| — b92-bv13 | — b92-bv15 | — b92-bv17 | — b92-bv19 | — b92-bv21 | — b93-bv12 | — b93-bv14 | — b93-bv16 | — b93-bv18 | — b93-bv20 | — b94-bv11 | — b94-bv13 | — b94-bv15 | — b94-bv17 | — b94-bv19 | — b94-bv21 |
| — b95-bv12 | — b95-bv14 | — b95-bv16 | — b95-bv18 | — b95-bv20 | — b96-bv11 | — b96-bv13 | — b96-bv15 | — b96-bv17 | — b96-bv19 | — b97-bv12 | — b97-bv14 | — b97-bv16 | — b97-bv18 | — b97-bv20 | — b98-bv11 |
| — b98-bv13 | — b98-bv15 | — b98-bv17 | — b98-bv19 | — b98-bv21 | — b99-bv12 | — b99-bv14 | — b99-bv16 | — b99-bv18 | — b99-bv20 | — b100-bv11 | — b100-bv13 | — b100-bv15 | — b100-bv17 | — b100-bv19 | — b100-bv21 |

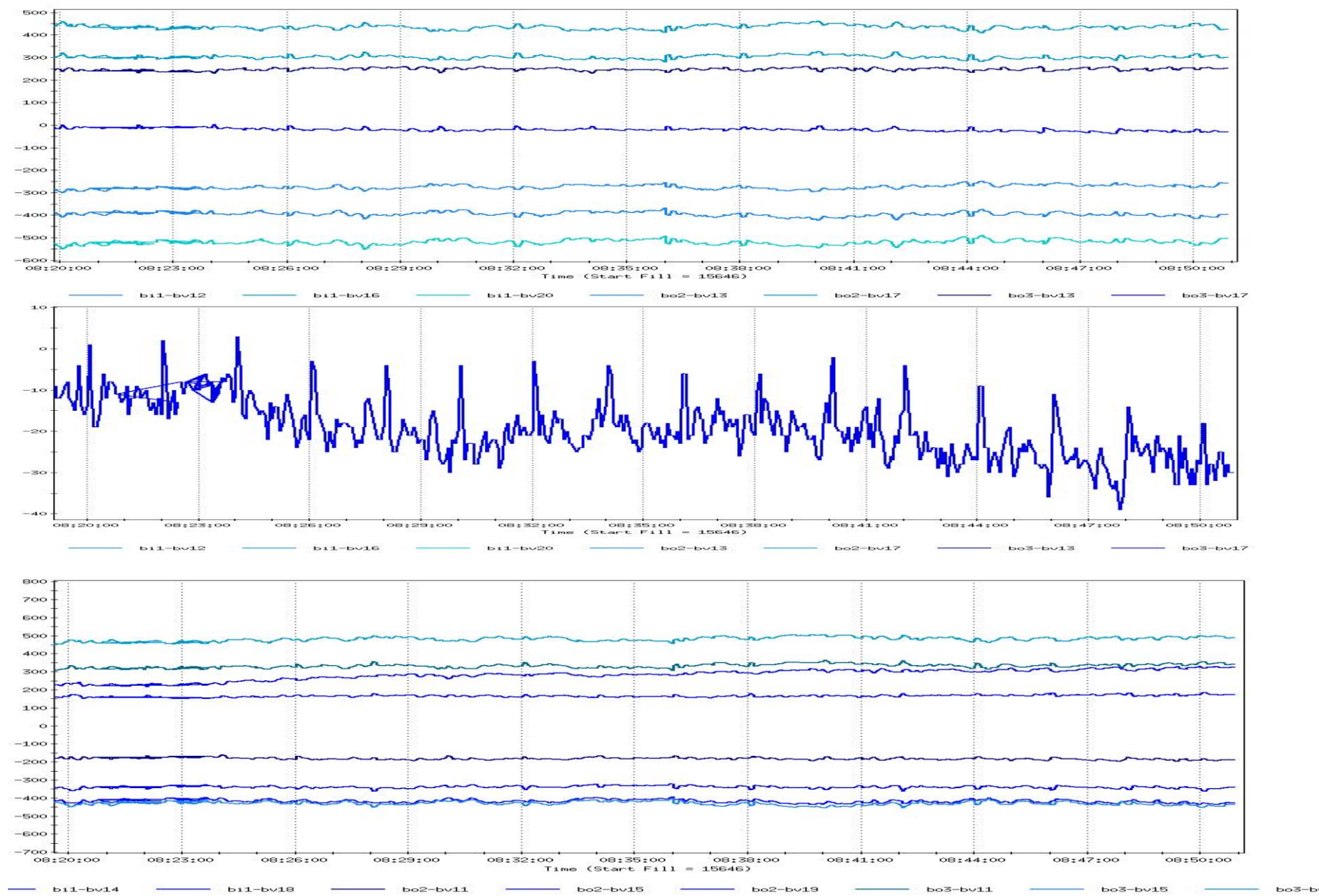
every-other even # BPMs in inner arcs, every-other odd # BPMs in outer arcs:

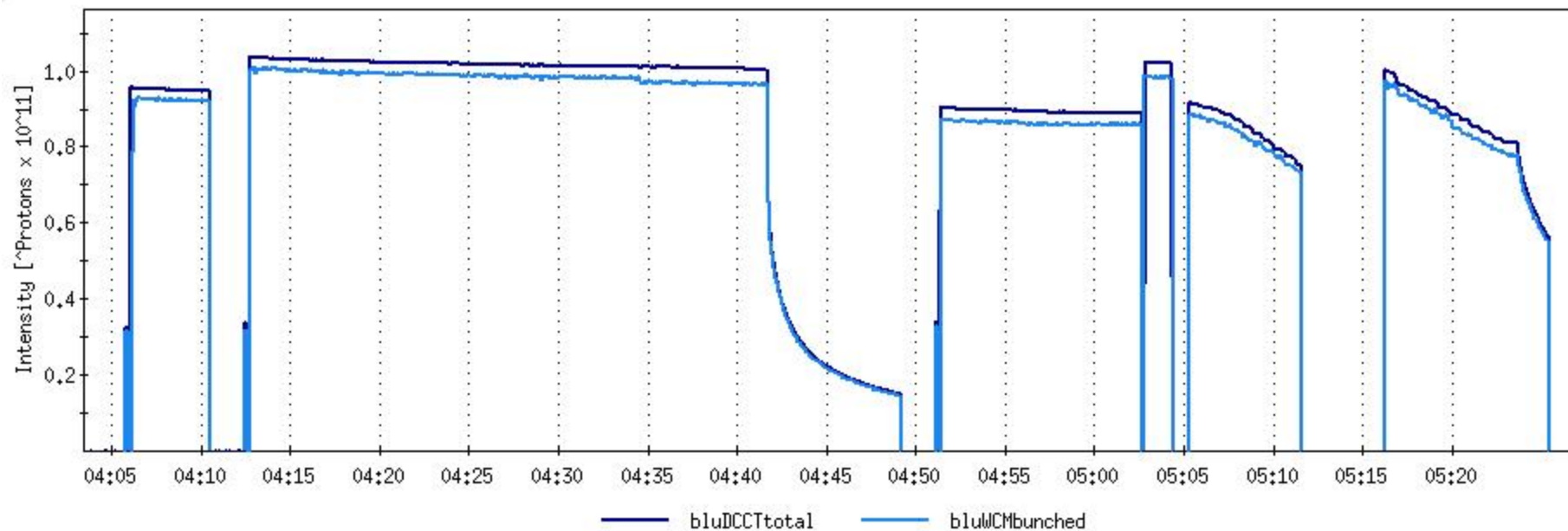


not-understood perturbations to closed orbit

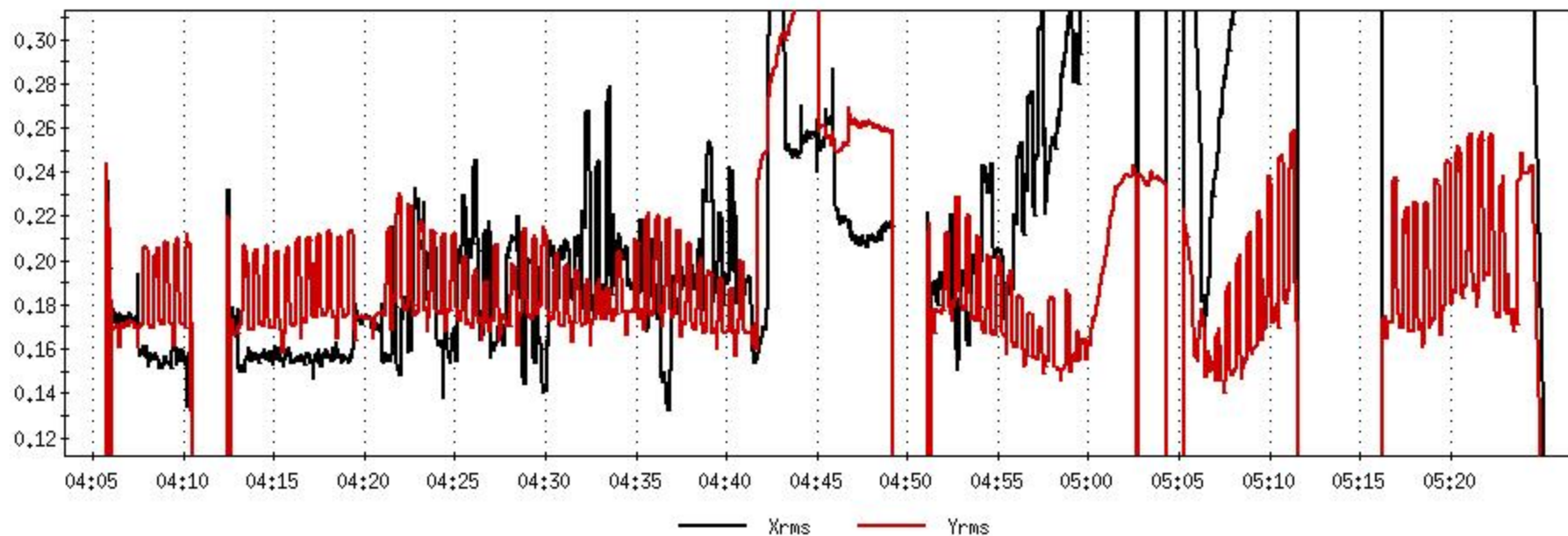
slight deviations in beam response to quadrupole change?

- ⇒ increase settle time from 4 to 10 seconds
 - ⇒ localize and remove perturbation, if possible
 - ⇒ increase number of orbits to average from 4 to 20
- (expect precision to improve at higher beam energies)





Blue Arc BPM Orbit Statistics



BBA plan for 05/02/11 (preliminary)

9 GeV, Au
28 MHz

Goal(s): identify possible sources of systematic errors
demonstrate reproducibility
test 2 codes

if time permits: acquire data at IP6 and/or IP12 (that order?), however we will request time for similar at high energy when conditions allow

Pre data acquisition:

- evaluate (if applicable) time-dependencies due to persistent currents
(make APEX backup plan if present?)

- ensure large proximity to resonance

- separate tunes, measure coupling and correct if needed

- verify BPM timing for gain optimized for (single-bunch) beam current available

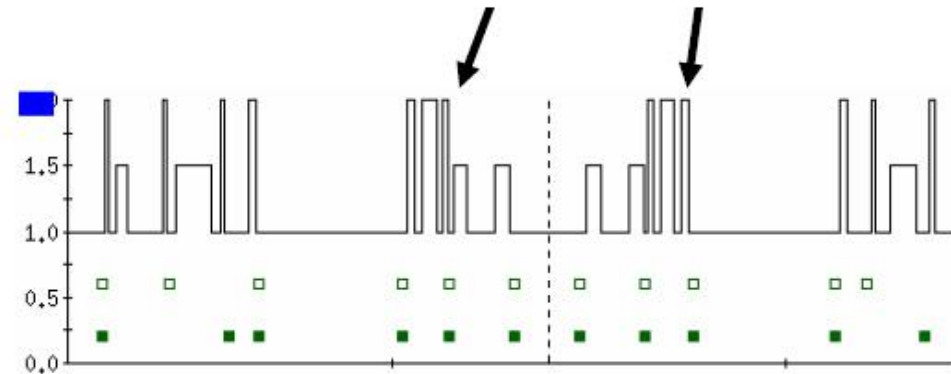
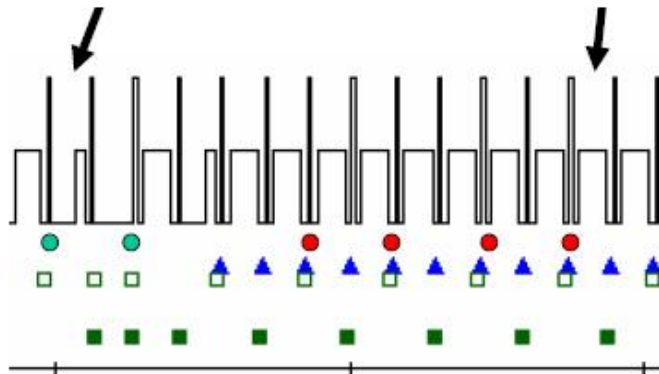
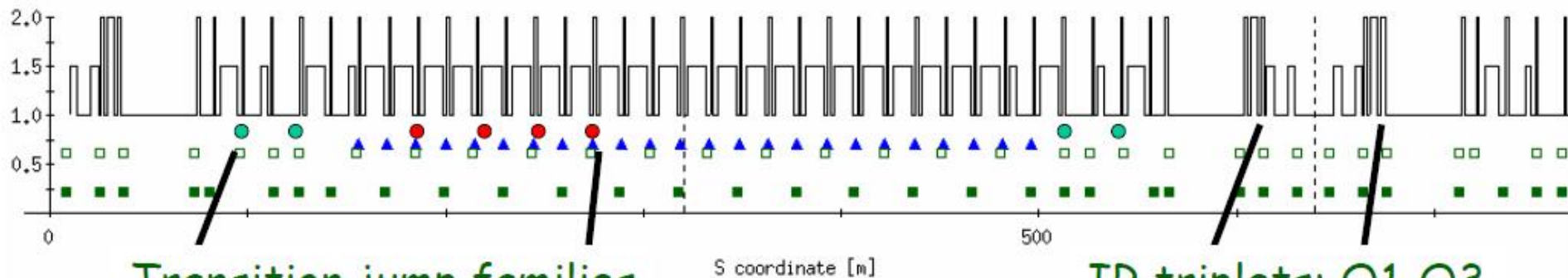
- ensure good starting orbit (using orbit feedback)

- (1) For fixed bump amplitude, acquire data with multiple on/off changes to quad of interest (to verify settle times, number of acquisitions, check for external noise sources,... determine anticipated resolution / error bars associated with each subsequent data point)
- (2) Iterate 3 measurements for a given BPM (vertical first, then horizontal)

RHIC BPMs and BBA layout

One sixth of one RHIC ring:

6 IR quadrupoles, 54 BPM planes, 24 chrom sextupoles (2 families),
transition jump quadrupoles (2 families)



DX BPM survey values (2001), units meters

| COORDINATES (actual) | | LIST/EDIT | |
|----------------------|----------|-----------|----------|
| Point ID | X | Y | Z |
| ===== | ===== | ===== | ===== |
| 01BPMCTR | -0.00355 | 0.00236 | -8.20907 |
| 02BPMCTR | 0.01134 | 0.00702 | 8.20775 |
| 03BPMCTR | 0.00273 | 0.01338 | -8.20661 |
| 03FLANGE | 0.00215 | 0.00595 | -8.52228 |
| 04BPMCTR | -0.00068 | 0.00037 | 8.18842 |
| 04FLANGE | -0.00062 | 0.00051 | 8.50334 |
| 05BPMCTR | -0.00395 | 0.00354 | -8.19621 |
| 05FLANGE | -0.00238 | 0.00159 | -8.51092 |
| 06BPMCTR | 0.00647 | 0.00448 | 8.21794 |
| 06FLANGE | 0.00496 | 0.00099 | 8.53295 |
| 07BPMCTR | -0.00607 | -0.00063 | -8.21241 |
| 07FLANGE | -0.00119 | -0.00250 | -8.52701 |
| 08BPMCTR | 0.00363 | -0.00068 | 8.19758 |
| 08FLANGE | 0.00230 | -0.00111 | 8.51242 |
| 09BPMCTR | 0.00100 | 0.00173 | -8.20348 |
| 10BPMCTR | 0.00404 | 0.00050 | 8.20328 |
| 11BPMCTR | -0.00011 | 0.01307 | -8.20648 |
| 11FLANGE | 0.00033 | 0.00588 | -8.52070 |
| 12BPMCTR | 0.00019 | 0.00045 | 8.20677 |
| 12FLANGE | -0.00031 | 0.00004 | 8.52219 |